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ABSTRACT

A study was conducted to investigate the effects of symbolic format of test material on short- and long-term recognition. Subjects, 104 undergraduate students, viewed slides of either a black-and-white photograph, a one-sentence verbal description of the photo, a black-and-white drawing based on the verbal description, or a black-and-white line drawing based on the verbal description with embellishments borrowed from the original photograph. In the study phase of the investigation, subjects were asked to pay attention to the slides, which were presented one every 5 seconds, and informed that a memory test was to be given after the viewing but that the test did not require them to remember the order in which the pictures were presented. During the test phase, subjects were presented with 57 slides. The slides were presented in the same room and manner as the earlier slides except that the test slides were presented at a rate of one every 8 seconds. Two days later the subjects were given a second recognition test. The study indicated that (1) the most important factor affecting retention is the type of feature encoded, not how many per se; pictures directly assess semantic information but additional details of color or realism of photos versus drawings are not important for recognition; and (2) retention might partly be a function of characteristics of the test cues. That they do not greatly influence performance is indicated by the fact that there were no significant differences between the study-picture/test-picture and study-picture/test-word conditions. (HOD)

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PICTURE DETAILS IN RECOGNITION MEMORY

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ABSTRACT

PICTURE DETAILS IN RECOGNITION MEMORY

Nelson, Reed, and Metzler (1974) reported that the amount of detail in pictures had no effect on picture recognition: line drawings based on detailed photographs were recognized as well as the photographs themselves, and much better than verbal descriptions of the photographs. This study was an attempt to support this finding, as well as an attempt to simultaneously test the relative importance of test-item format on recognition. Paivio (1976) found that there was no effect of changing the item format at the time of an immediate test. When study items were pictorial, recognition was better than words regardless of the test format. In the present study, subjects viewed slides of either photographs, drawings, or typed words of single common objects. In an immediate test and a 48-hour delayed recognition test, some subjects were tested with duplicates and distractors in the same mode while other subjects were tested in a different format (i.e., with slides of typed words which were the verbal referents of the same objects in the study phase, or distractors). Results indicate that the number of details of pictorial items does not play a factor in recognition and that there is no test item format effect over a 48-hour period.

CHAPTER I

INTRODUCTION

This paper reports a study of the effects of symbolic format of material on short and long-term recognition. In particular, the study deals with aspects of the picture superiority effect. Under a wide variety of conditions and test procedures, pictorial representations of to-be-remembered material are rembered much better than verbal representations (Paivio, 1976). The specific focus of the present study was on the effects of pictorial elaboration (amount of picture detail) on recogntion. The study developed out of two sets of findings in the literature.

Nelson, Reed, and Metzler (1976) hypothesized that any recognition advantage for picture over verbal descriptions might be in terms of the extra details typically provided by pictures but not by words or verbal descriptions. If the subjects encode additional pictorial details during the study phase, then recognition of any one of those details during testing could serve as the basis for distinguishing the target picture from the distractor. Nelson et al. directly manipulated the number of details in the to-be-recognized pictures to determine if extra pictorial details facilitate recognition. The visual stimuli presented to the

subjects were either a black-and-white photo; a one sentence verbal description of the photo; a black-and-white drawing based on the verbal description; or a black-and-white line drawing based on the verbal description with embellishments borrowed from the original photograph. The second independent variable was the retention interval for the recognition test. Subjects were tested immediately after the study phase and then again after a period of seven weeks. As expected, recognition was significantly better for the immediate test than for the delayed condition. All photos and drawings were recognized significantly more often than the verbal descriptions. There was also a significant interaction: recognition accuracy declined more slowly for the photos and drawings than for the verbal descriptions. There were no significant differences between the photos and the two types of line drawings.

The other line of research relevant here deals with the test format. Paivio (1976) presented subjects with either pictures or their verbal labels and then tested them in either the same mode or other mode (e.g., study-word/test-picture). His results indicate that input pictures were recognized more often than words, regardless of test mode. In this case it would seem that the superiority of pictures over verbal labels at the time of encoding is much more important than the retrieval cues given.

In one way, the lack of a large effect of test-item format can be regarded as consistent with and extending the conclusions reported by Nelson et al.: if picture detail is relatively unimportant in picture recognition, then eliminating all detail (at the time of test) by presenting a verbal label only should still produce picture superiority. The present experiment was designed to test this hypothesis by combining the Nelson et al. picture detail manipulation with variation in study and test-item formats. If both sets of findings are to be supported, then it is expected that performance of conditions in which the study item is pictorial should be better than words, regardless of the amount of study-item detail (i.e., photo vs. drawing) or test format (i.e., tested with pictures vs. tested with words).

In the present study, recognition was tested for color photographs of single objects, black-and-white line drawings based on those photographs, and the single word names of those objects. The present endeavor is similar to the Nelson et al. study with some important modifications. First, they used only black-and-white photographs while color is used here. Single objects are the stimuli which may have an important effect on the differences between conditions. The use of multi-concept stimuli (e.g., a smiling old man holding a little girl) might possibly have provided a ceiling effect on the immediate recognition test.

Because of the less distinctive stimuli, using single object stimuli in the present study will remove this effect. Another difference is that this experiment uses a shorter study interval, five seconds per slide as opposed to ten. If pictures directly access the semantic code while meaning for verbal labels proceeds more slowly, then this shorter study interval should provide an even greater deficit for the study-word condition.

Most importantly, their study confounded input and output modality. To truly examine the effects of picture detail, it is necessary to include conditions in which the test mode is different from the study mode. If trace retention becomes partly a function of the characteristics of the retrieval cues when the test mode is different, then there should be differences at the immediate test between study-picture/test-picture conditions and study-picture/test-word conditions.

The first independent variable is the retention interval for the recognition test. Here, the delayed test is 48 hours after the study phase. It is hypothesized that the results will replicate the Nelson et al. study in this respect. That is, performance will decrease significantly over time. The second independent variable introduced here is that the test items may or may not be in the same mode as the study item. Specifically, half of the subjects that receive photographs or drawings will be tested in the same

mode, while the other half will be tested with its single word verbal name. It is hypothesized that those subjects tested with words will perform more poorly in the delayed test than those tested otherwise. It is hypothesized that there will be a significant interaction. In the immediate test there should be no differences between study-pictorial conditions, but at the delayed test study-pictorial/test-word conditions should perform more poorly than study-pictorial/test-pictorial conditions. Subsequent to the discussion of this experiment will be a general discussion explaining the inconsistencies between recognition and recall studies which deal with picture effects.

CHAPTER II

METHOD

Design

The basic design was a five by two factorial with repeated measures. The first factor (between subjects) concerns the study item-test item pairing: PP, DD, PW, DW, and WW (where P=photograph, D=drawing, and W=word). The second factor (within subjects) was the retention interval: an immediate recognition test and a 48-hour delayed recognition test. The dependent measure was item recognition on a six-point confidence rating scale. A rating of one indicated that the subject was absolutely sure that the test item did not correspond to a study item (i.e., a new item). A rating of six indicated that the test item corresponded to a study time (i.e., an old item).

Materials

A set of 114 names of relatively common objects was drawn up. Next, 80 of these were selected at random to serve as the study items. The remaining 34 items in the study served as distractors in the recognition test. All items were produced in three formats: typed words,

black-and-white line drawings, and color photographs. The photos included objects photographed in a natural setting (e.g., "tree," "tractor") as well as objects photographed against a neutral background of a plain floor. The drawings were produced by tracing rear-projected photo slides, omitting color and any background detail.

Each subject saw the 80 study slides in one of the formats. For the two-part recognition tests, these 80 study slides were duplicated and randomly assigned, 40 each, to either the immediate test or to the 48-hour delayed recognition test. The remaining 34 slides were randomly assigned, 17 each, to either the immediate test or to the delayed test and served as distractor items. The ordering of the old and new items in the test sequence was random. The recognition tests in all conditions consisted of a 57 item six-point confidence rating in which all items were presented in the same or different format. Subjects were provided with a sheet of paper with 57 blanks for their number ratings.

Procedure

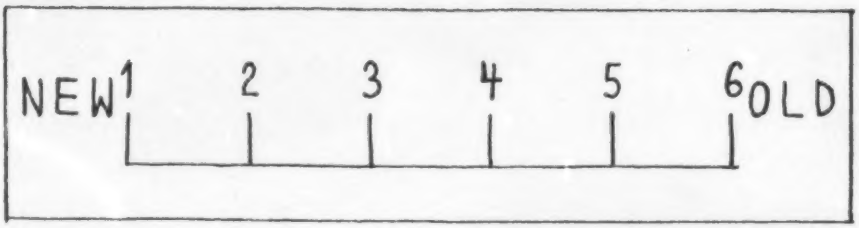
Subjects were first given test instructions. They were asked to pay attention to the slides that were to be projected on the wall in front of them. They were informed that a memory test was to be given after the study phase, but that the test did not require them to remember the order

in which the pictures were presented. Then the 80 slides were presented via a Kodak carousel projector at a rate of one slide every five seconds. At the onset of each slide, subjects heard the name of each over headphones. The slides were projected on a wall six feet in front of the subjects. The illuminated area of the display was 45 inches wide and 30 inches high.

At the end of the study phase, subjects were given instructions and materials for the first recognition test. The instruction sheet explained the rating scale (see Figure 1). A one, two, or three meant that they did not recognize the test item as being previously seen in the study phase in some mode. A one indicated that the subject was sure the item was a "new" item, with a rating of two and three indicating decreasing confidence in that decision. Likewise, a four, five, or six meant that the subject recognized the test item as being present in the study phase in some mode. A six indicated that the subject was sure the item was an "old" item, with a five and four rating indicating decreasing confidence in that decision. The subjects were then presented with the 57 test slides. Slides were presented in the same room and manner as in the study phase except that test slides were presented at a rate of one every eight seconds.

After the test, data sheets were collected and the subjects were reminded of the second experiment session to

CONFIDENCE RATING SCALE



NEW-a distractor

OLD-a duplicate slide or a slide of the typed word of the object seen pictorially in the study phase.

1 — This rating is chosen when the subject is positive the test item has not been seen in the study phase, regardless of format.

2 — This rating is chosen when the subject is less certain that the test slide does not correspond to a study phase slide.

3 — This rating is chosen when the subject is not sure but only thinks that maybe the test slide has not been seen before.

4 — This rating is chosen when the subject thinks that maybe the test slide does correspond to a slide seen in the study phase, regardless of format.

5 — This rating is chosen when the subject is more confident in the decision that the test slide does correspond to a study slide (an old slide).

6 — This rating is chosen when the subject is certain that the test slide corresponds to a study slide.

Figure 1. Explanation of the Confidence Rating Scale Used by Subjects in the Recognition Test.

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occur two days later. Information was not given that the second session would only consist of a second recognition test. They were asked not to discuss the details of the experiment with other subjects. Two days later the second recognition test was administered in the same manner as described for the immediate test.

Subjects

The subjects, run in groups of two to five, were 104 undergraduate students at the University of Southern California. Their participation fulfilled an introductory psychology course requirement. Subjects were assigned to conditions according to a block randomization procedure. Attrition from subjects not appearing for the second recognition test resulted in loss of data from four subjects. Complete data were collected from 20 subjects in each condition.

CHAPTER III

RESULTS

The six point rating scale was used to compute two dependent measures: a' and percent correct. The measure of a' is a nonparametric version of d' associated with Theory of Signal Detection (Pollack and Norman, 1964; Pollac, Norman, and Galanter, 1964; Pollack, 1970). The values of a' can vary from .5 to 1.00. The measure of a' is evaluated by true and false positives (hits and false alarms). A hit occurs when the subject correctly detects an old item (i.e., one that was presented in some mode in the study phase). A false alarm occurs when the subject responds "old" to a new slide (i.e., one that does not correspond to a slide in the study phase). The correlation was very high between a' and percent correct (r=.964). Figures 2 and 3 show the results for both measures to facilitate the interpretation of a' in terms of the more familiar percent correct measure.

A mixed design analysis of variance (repeated measures for the retention interval factor) was computed on the a' values (see Table 1). There was a significant main effect for the study/test pair conditions [$F(4,95)=4.78$, MSerror=.007, $p<.005$]. Duncan multiple comparisons tests revealed

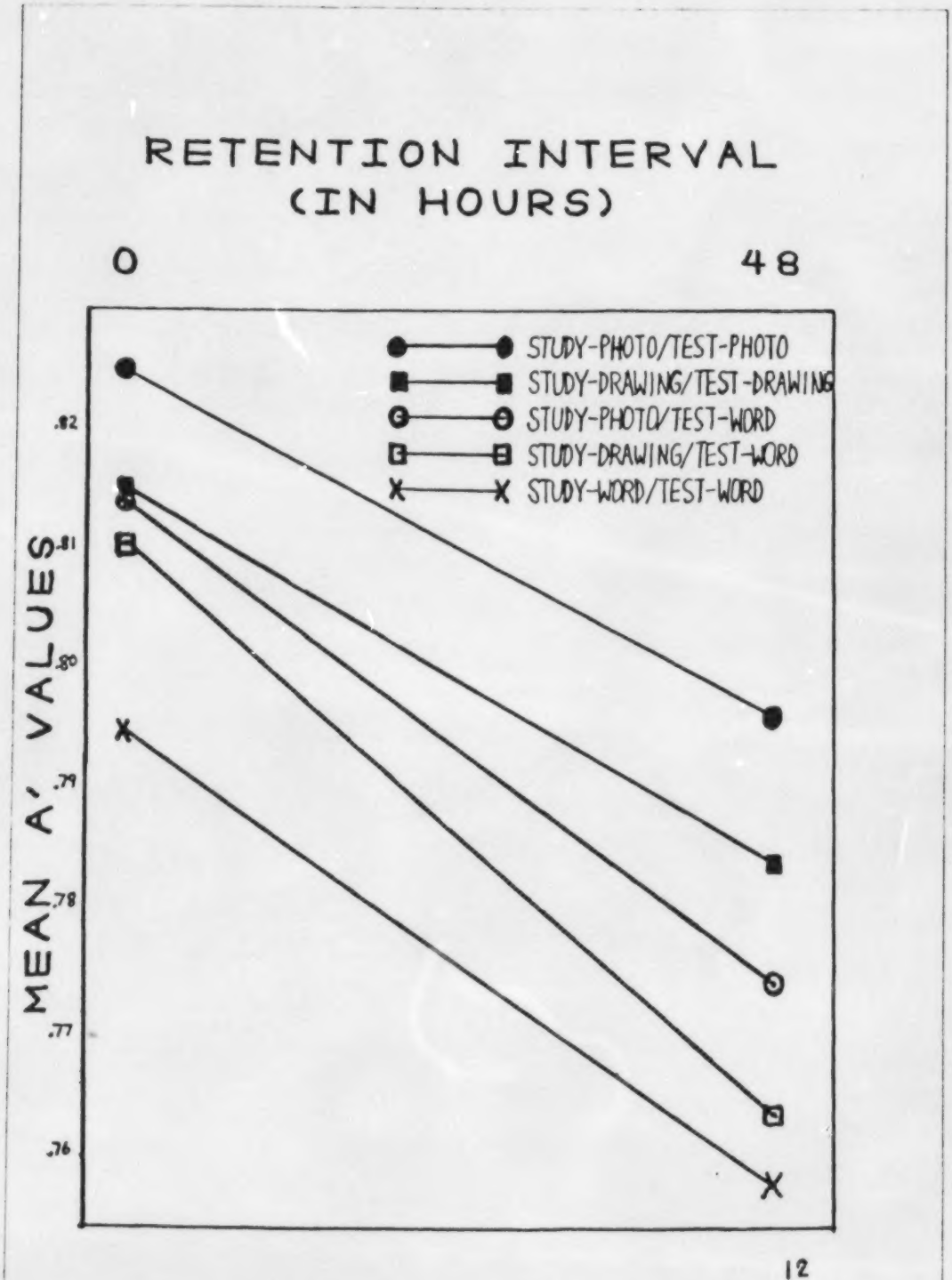

Figure 2. Mean Values of a' for Each Study/Test Pair Group (PP, DD, etc.) at Immediate and Delayed Recognition Test.

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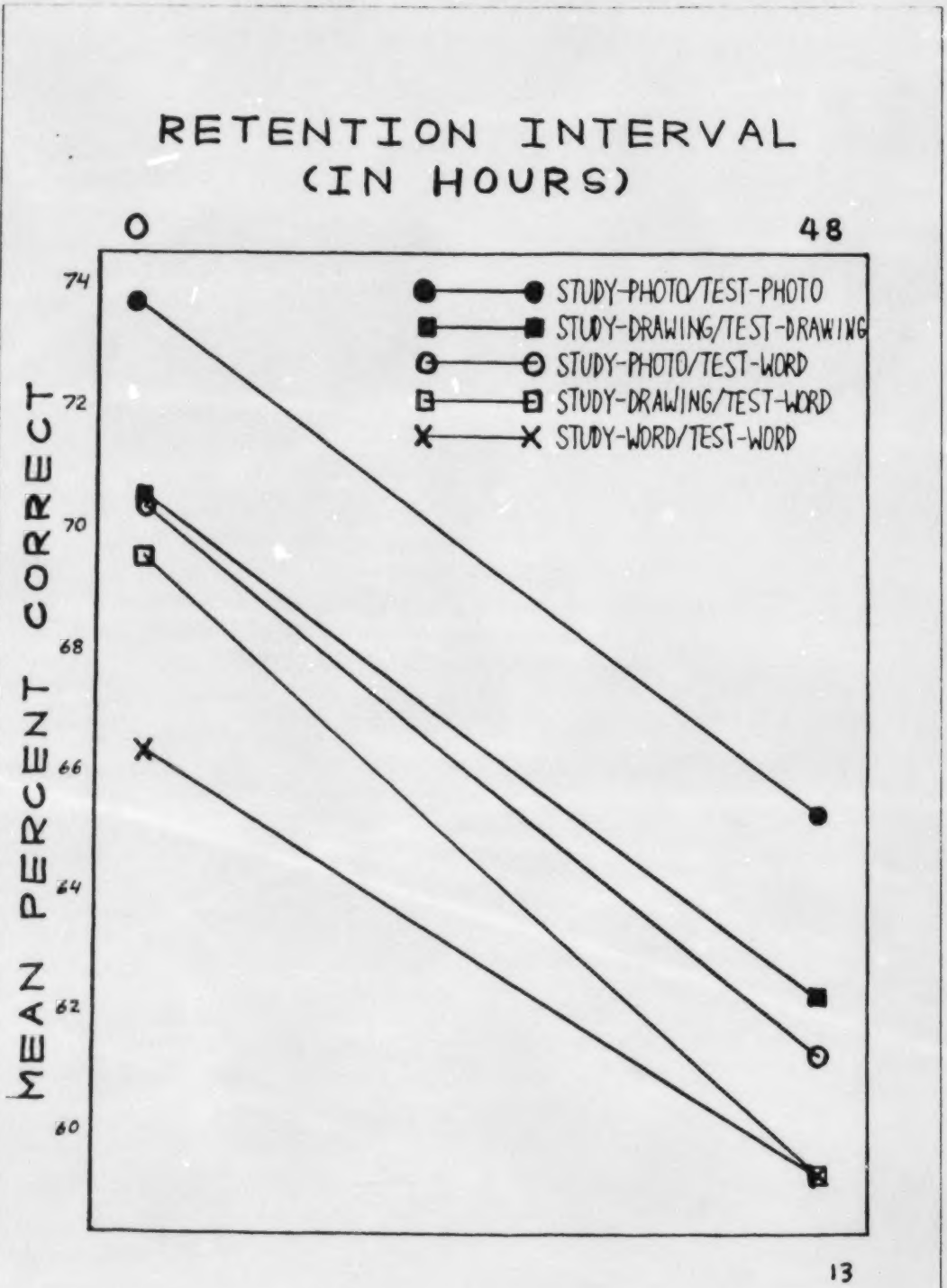

Figure 3. Mean Values of Percent Correct for Each Study/Test Pair Condition (PP, DD, etc.) at Immediate and Delayed Recognition Test.

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TABLE 1

Analysis of Variance with Repeated Measures on a' Values

Source	SS	df	MS	F	p
Study/Test Pair Groups	.028	4	.007	4.78	.0015
Error	.1393	95	.0014		
Retention Interval	.0694	1	.069	83.9	.0000
Study/Test Pair Groups by Retention Interval	.0022	4	.0005	.68	.6077
Error	.0786	95	.0008		

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that the study-word/test-word condition performed significantly worse compared to all of the other conditions except for the DW condition. This result supports Nelson et al.'s study; pictures are remembered better than words not on the basis of the number of picture details. If the number of picture details were important, then performance of memory for photos would have been higher than for drawings.

The main effect for the repeated measures variable of retention interval was highly significant [$F(1,95)=83.9$, $MSerror=.07$, $p<.0001$]. As expected, memory for pictures and words decrease over time. But the hypothesis of a significant interaction was not realized. Performance of memory for photos, drawings, and words decreased at approximately the same rate. Memory did not decay more rapidly for words, as in the Nelson et al. study. The conditions in which there was a format change also did not decline in performance at a faster rate than the same-mode conditions. In the delayed test, performance on pictorially studied items tested with their verbal referent was somewhat lower than if tested in the same mode or format. Paivio's study (1976) was confirmed in that there was no test format effect in the immediate test. There was, however, a non-significant trend of a test format effect in the delayed test.

Concerning the measure of percent correct, performance in the present study was poorer compared to the Nelson et al.

study. This may have been because of the less distinctive stimuli, and/or because of the shorter study intervals used in the present experiment. All conditions in their study yielded about 95 percent correct for the immediate test and around 87 percent correct for most conditions of the delayed test. The exception was the verbal description condition which provided the significant interaction. Performance in the present study never exceeded 74 percent. Hence, the significant interaction of Nelson et al.'s study may have been a ceiling effect.

CHAPTER IV

DISCUSSION

The results yield the expected rank ordering of study/test pair conditions. In descending order of performance the conditions are ranked as follows: PP, DD, PW, DW, and WW. The study-word/test-word condition performed significantly worse compared to most of the other conditions. This is the familiar picture superiority effect. There were no significant differences between the pictorial conditions. This confirms the Nelson et al. study in that it does not matter how embellished the picture is or how many details are present. Superior retention is due to the visual distinctiveness of pictures in a way which words do not possess.

The results indicate that in the immediate test the study-picture/test-word conditions were not significantly different from the study-picture/test-picture conditions. This points to the conclusion that trace retention is mostly a function of the types of features encoded. But detecting a pictorial study item given a pictorial test item should require less processing than detecting a pictorial study item given its verbal level as the test item. Because words are processed differently from picture details, a

correct detection of a word as an old item should require more search. Testing pictorially studied items with words means that there is a slightly weaker signal because the verbal label information accesses first the individual's concept of an item which then is stimulated by the more distinctive trace cues left by the pictorial study item. The results do not support these arguments. This effect of modality change is in the correct direction, but it is quite small. The conclusion is that picture effects are primarily an encoding (or input) effect. The results discount any explanation of picture superiority in terms of recognition of isolated picture details or partial recognition at the time of testing. The effect of using color slides produced no significant advantage in the present study. The belief that picture superiority is a simple consequence of partial recognition or attention to specific details seems unfounded.

Nelson et al. proposed a conservation of processing hypothesis. In a fixed amount of processing time, a constant amount of information about the picture is stored. If one picture has few details, and another has many, storage of details of the former will be more complete. For the latter, subjects will store a relatively small amount of information about each detail. The result is that the total amount which is stored for the two pictures will be the same. This hypothesis seems to have some explanatory value here.

It is important to remember that picture superority is not accounted for by attention to isolated details or partial recognition. For example, subjects in the PW and DW conditions performed something of a cued recall test in a way that the PP and DD subjects did not. Even though the pictures were not present at the time of the test for the former conditions, performance was nearly as good as if they had been present. But the slightly poorer performance of the PW and DW conditions in the delayed test suggests that the characteristics of the test cues may play a role in retrieval over time. The present study, however, does not find any strong evidence for this.

Recall Versus Recognition

The results of recognition studies which examine modality and picture detail effects contrast sharply with results of recall studies. Bousfield, Esterson, and Whitmarsh (1957) presented subjects with either a word, a word with its black-and-white drawing representation, or a word with its color drawing representation. Recall was improved significantly proceeding from the word-alone condition to the latter conditions. Also, subjects in the word/color drawing condition performed significantly better than the subjects in the word/black-and-white drawing condition.

Vander Meer (1954) compared the effectiveness of learning with the use of color film and the same film in

black-and-white. His results indicate that the factor of color resulted in no significant gain for the immediate acquisition of learning. On the other hand, later testing indicated that the use of color resulted in some degree of reduction in the rate of forgetting.

Madigan and Lawrence (1980) found the usual pictorial superiority over verbal referents, but additionally found that recall of photographs was superior to line drawings. These results imply that the phenomena examined is sensitive to differences in recall and recognition.

The results of these three recall studies is completely different from the recognition studies which have been discussed. As a possible explanation, Tulving (1976) argues that differences between recognition and recall have to do with retrieval. Retrieval is a joint product of information from two sources, the memory trace and the retrieval environment. This implies that with the amount of trace information held constant, the level of retrievel performance is a monotonically increasing function of the amount of relevant retrieval information. Alternatively, with the amount of retrieval performance is a monotonically increasing function of the amount of trace information. In recall studies, only general retrieval information (i.e., context or episodic) is given, while in recognition studies, both general and specific retention information are combined with trace information.

Recall and recognition are different because retrieval information which is present at the time of recall is different from that of recognition. For these recall studies where the amount of retrieval information is held constant (i.e., the general type), performance will increase with a greater amount of trace information. In recall studies, then, the effect of color will be relevant, and photographs will be recalled better than drawings. For recognition studies, on the other hand, specific cues supplement general retrieval information, and the differences disappear.

Picture Effects

Picture effects may be explained by a number of approaches. Three of these approaches will be addressed here: the depth of processing approach, the dual code approach, and the propositional representation approach. For the depth of processing approach, encoding operations which are directed toward meaning seem to invariably produce higher amounts of recall (Craik and Lockhard, 1972; Craik and Tulving, 1975). Craik and Lockhard (1972) suggest that the mneumonic effectiveness of a stimulus is a direct function of the "depth" to which that stimulus is analyzed during encoding. The task of word categorization, which necessitates semantic analysis, results in better memory than word naming which does not require the meaning of the word to be

completely understood. In contrast, performance of memory for named pictures is superior to memory for categorized pictures (Smith and Magee, 1980). If it is assumed that naming engenders a more shallow level of encoding than categorization, a simple level-of-processing view cannot account for this result. By a depth of processing approach, there is no prior reason to predict differential memory for pictures under the two tasks, given that both require semantic analysis. A more elaborate account must specify other relevant processing factors, such as specificity of the semantic encoding. It may not be so much the depth of processing per se, but rather the effort required for that processing.

Picture effects may also be addressed by the dual code approach in terms of both imaginal and verbal processes. These processes involve independent but partially interconnected systems for encoding, storage, organization, and retrieval of stimulus information. Independence of the two codes implies that either one can be available and activated in varying degrees. The codes may have an additive effect on performance. One code can be transformed into the other, so that pictures can be named, words can evoke non-verbal images, and similar transformations can occur.

Since there is little effect of the test format in a recognition task, the important aspect of picture superiority seems to be an encoding effect. It may be accounted

for in terms of the relative distinctiveness of their visual features. Alternatively, the superiority of picture memory might be explained in terms of inherent differences in the distinctiveness of meaning features. To examine this possibility, Nelson, Reed, and Walling (1976) used pictures or their labels as paired-associate stimuli and unrelated words as responses. Visual similarity among pictures was either high or low, and the stimuli were selected either from the same conceptual category or from different conceptual categories. The results of the experiment indicated that high visual similarity eliminated the pictorial superiority effect. Equal amounts of conceptual interference were produced for pictures and their labels. Meaning interference seems to be independent of the kind of stimulus producing it.

This suggests that the functional meaning representations are identifical for both pictures and words.

Smith and Magee's (1980) results support the assertion that meaning representations are the same for words and pictures, but that semantic and articulatory information become available differentially. The relative difference in the difficulty of remembering pictures and words may result from the differential ease of accessing these various forms of information.

Data from decision latency (Pellegrino, Rosinski, Chiesi, and Siegal, 1977), memory (Shulman, 1971), naming

latency (Potter and Faulconer, 1975), and picture-word interference tasks (Rosinski, Golinkoff, and Kukish, 1975) all suggest that articulatory and semantic information become available at different rates for pictures and words.

Pictures make contact with the semantic code very rapidly, but more processing is required to access a name code. In contrast, words may be pronounced very quickly, but accessing the semantic code proceeds more slowly. Within this framework, Smith et al. (1980) reports that pictures access semantic information prior to articulatory information and that the reverse order of information access is available for words. They conclude that memory is dependent on the effort required for processing, as mentioned before.

This model is similar to one developed by Nelson (1979), and Nelson, Reed, and McEvoy (1977). Their sensory-semantic model assumes that both pictures and words access a common meaning code, but that pictures do this more directly than words. It is assumed that the superior retention of pictures is reflected by the differences that exist in the surface characteristics of words and pictures (i.e., the sensory code). The superiority of pictures is tied to the visual features of pictures versus words. In the present study retention performance was not significantly different for photographs and drawings because the task was one of recognition, but performance of these conditions was still

significantly greater than words because of their more distinctive visual features.

One problem with the dual code approach is that picture superiority does not routinely or automatically result in the generation or activation of a corresponding verbal code (Nelson, 1979). Pictures may be readily and quickly named, if the task requires it, but it does not occur unelicited. Furthermore, suppression of the name code or interference with its generation does not minimize picture superiority to a significant degree. This leads to an assumption that the sensory code has more importance, at least in some cases.

The propositional representation position as proposed by Anderson and Bower (1973) has applications to this discussion. A proposition is the general, abstract form of representation, which is not limited to verbal-semantic knowledge. Human memory retains modality information. Propositions can express both semantic and perceptual information effectively; both kinds of information are stored in memory. Recent computer simulations support this assertion (Baylor, 1972; Farley, 1974).

Given the above, it might be that picture memory is superior because the image information provides simple redundancy in connections. Properties that are found only in perceptual descriptions facilitate recall. Even though picture and word representations may both have the same

propositional network format, there may be differences in the components, the concepts, and the relations used in the representation (Kieras, 1978).

It might be that pictures are more easily recognized than words due to the pictorial qualities rather than the verbal codability. This durability in storage could be due to some superior resistance to loss of perceptual concepts and relations. Perhaps the storage of a picture representation produces better performance because the integrated quality of image permits redinegrative recall. The integrated quality is due to its perceptual features, such as a Gestalt-like principle of figural unity. In contrast, verbal representations do not have such unitized properties and so are subject to less reliable memory performance. A well-integrated memory structure is simply one that has many redundant connections that firmly tie the material together and also connect it with permanent memory information.

Since it has been concluded that picture superiority is attributed for the most part to the encoding process, recognition performance of study-picture conditions would all be about the same (regardless of test mode), given the integrated quality of the memory structure afforded by pictures. For the study/test word condition it is more difficult to make an accurate detection of an old item. Processing of the verbal test item accesses the concept node of the

prototypical representation where it finds little redundancy, which results in significantly poorer performance.

This approach may also have problems dealing with picture effects. In a study by Stopher and Kirsner (1981), subjects were required to classify events as true or false after observing picture or verbal descriptions about the relationship of two objects (e.g., "the apple is on the table"). A fan effect occurred for verbal material in which reaction times were longer for tests that involved events with shared features. No such effect occurred for the pictorial material. This indicates that picture and word processing and memory may be qualitatively different which is in violation of the propositional representation assumption that memory depends on common representational and retrieval systems.

Those theories which assume different representational formats for nonverbal and verbal material are supported by many of the results in this research area. Where the differences occur between the imaginal-sensory representation and the verbal-conceptual representation should be the emphasis of future research. As are indicated by the results of the present study, the notion of a strong and effective sensory representation (encoding) has a great deal to do with the picture superiority effect.

To summarize, the most important results of this study are that (]) the most important factor affecting

retention is the type of feature encoded, and not how many per se. Pictures directly access semantic information but additional details of color, or realism of photos versus drawings are not important for recognition. (2) To a much lesser extent, retention might partly be a function of characteristics of the test cues. That they do not greatly influence performance is indicated by the fact that there were no significant differences between the study-picture/test-picture and study-picture/test-word conditions.

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